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Zarafshan Wind Farm Shutdown on Demand Feasibility Report

Prepared for Wood

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TURNSTONE ECOLOGY

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1. INTRODUCTION

1.1. Overview

This document has been prepared by Turnstone Ecology for Wood in relation to the proposed 500 MW Zarafshan Wind Farm development near Zarafshan City, Tamdy District, Navoi, Uzbekistan (the Project). The Project is being developed by Masdar (the Developer) with the Power Purchase Agreement and Investment Agreement signed with the Uzbek Government in June 2020.

The Developer has been asked by the panel of Lenders to provide clarity and certainty on the feasibility of the proposed Shutdown on Demand methodologies as detailed in the Project's ESIA documents. The need for Shutdown on Demand has been informed by surveys completed at the Project site between October 2019 and June 2021 (with surveys for breeding birds ongoing until July 2022) which identified that the Project has the potential to locally extirpate certain bird populations and have permanent effects on the viability of the adjacent Important Bird Area (Mount Aktau IBA).

1.2. Background

At present, several species of bird have been identified to be using the Project site and surrounding areas which, due to their conservation status and/or their flight characteristics, could be sensitive to the impacts of the proposed Wind Farm. The usage by such species has been year-round and the distribution of observed activity has been across the entire site. Nest surveys have also identified nest sites within and adjacent to the Project area and further nest surveys are being completed between February and July 2022.

Bird surveys through 2020 and into Spring 2021 identified movements of Griffon Vulture, Egyptian Vulture, Cinereous Vulture, Golden Eagle, Saker Falcon, Steppe Eagle and Bearded Vulture through the Project Area. In addition, species such as Golden Eagle, Steppe Eagle and Saker Falcon have also been recorded in and around the Project area and Collision Risk Modelling has highlighted annual mortality for each of these species for the duration of the Project with the predicted collision rates detailed fully in the ESIA. The Project aims to achieve no net loss for the populations of these species over the lifespan of the Project, annual mortality targets will be further informed by the ongoing nest surveys which will give up to date data for the numbers of resident breeding species in the area.

The full priority species list for those species requiring shutdown from the start of the Project is shown below:

Shutdown required for any individual of the following species of high conservation status (IUCN Red list, Red Data Book of Uzbekistan and/or reasons for designation of the neighboring IBA)

- Cinereous Vulture
- Egyptian Vulture
- Eurasian Griffon Vulture
- Bearded Vulture

- Golden Eagle
- Imperial Eagle
- White-tailed Eagle
- Macqueen's Bustard
- Steppe Eagle
- Booted Eagle
- Saker Falcon

Shutdown required for flocks of 50 or more of the following species that have the potential to move though the area in large groups and are susceptible to impacts from turbines, particularly in larger groups:

- Common Crane
- Greylag Goose
- Demoiselle Crane
- White-fronted Goose

The requirement for 50 birds is based on the ability of such species to avoid wind farms from a good distance away in smaller flocks. Identiflight is able to count birds within a flock however a buffer can be built in so that flocks slightly smaller than this a stopped for also.

1.3. Site Visit

A site visit was completed in December 2021 by a team of experts comprising Lenders' representative, Alvaro Camiña, along with Wood's representatives: ecologists Tristan Evans and Simon Parker of Turnstone Ecology, Caleb Gordon of Xenops Environmental, Victoria Filatova and Alisher Ataxodjaev of Juru Energy, along with Uzbek social specialists Saida Yusupova and Fazlullo Agzamov of Green Business Innovation.

The visit scope included the aim of assessing the feasibility (both technical and logistical) of observer led shutdown and to also to see if any technology led shutdown could be feasible. Technical feasibility included factors such as observers viewsheds being able to cover all proposed WTG locations and buffer as well as allow sufficient time for shutdown to be initiated. Logistical feasibility included factors such as the ability to provide and train all required observers year-round. The assessment of practical feasibility was assisted during the trip by interviewing local ornithologists to find out about the levels of in-country experience available and about environmental/ecology related degree programmes at Uzbek Universities.

During the site visit, the turbine locations were discussed in detail and the major outcome of the visit was the revision of the layout. The aim of the layout revision was to move turbines away from areas of highest likely interaction with birds (i.e. away from ridges used to gain height flying and from known nesting sites). This has the immediate effect of reducing the likely need for turbine shutdown but also increases the likelihood of shutdown working as birds are less likely to appear from below ridges straight into the path of turbines. The exercise concluded with the movement of 15 turbines: 11 of which were microsited and 4 of which were macrosited away from high-risk areas.

2. SHUTDOWN ON DEMAND

2.1. Background

Shutdown on demand involves targeted shut down of WTGs in the event that any individual priority species or significant flock of non-priority species flies within a buffer distance of WTGs and is on a flight path that would bring the bird into close proximity of the turbine blades. 600m is considered an appropriate buffer based on the time taken to shut turbines down, the flight speed of the bird species in the area and the distance an individual is likely to travel within that certain period of time. It is important to note that observer viewsheds would target a wider area than 600m to ensure best opportunity for bird detection and species identification.

Two scenarios, observer led shutdown and technology led shutdown, were explored as part of this process, with the feasibility of each considered in the context of field practicalities/conditions, the physical properties of the site, in-country experience base, estimated costs and effectiveness.

In addition to the on-site work, the Developers representatives, along with members of the Lenders biodiversity expert team, have consulted with an existing project where the Identiflight system is in operation (broad discussion have taken place with Identiflight over wider project but detailed discussions have taken place with Cattle Hill), as well as the Identiflight owners and developers. This has allowed for open sharing of information and detailed question and answer sessions where all parties were able to engage. Options are discussed in detail within Sections 2.2 and 2.3 below.

2.2. Observer led shutdown

The first scenario explored was the use of observers to trigger turbine shutdown across the Project site and throughout the year, most likely for the duration of the project. As mentioned above, a field mission was undertaken in December 2021 to ground truth potential VPs for the observer led shutdown; to find out more about in country capabilities; and to highlight potential issues with site access, communication and coverage.

Appendix 1 at the end of this document shows the considerations that were made at each survey point (*e.g.* obstacles to viewshed, coordinates of surveyor location) and *Appendix 2* gives a number of photographs from selected VP locations.

2.2.1. Technical Feasibility

Initial desk-based studies estimated that a minimum of 21 observer points would be necessary to cover all the proposed WTG locations, this was based on topographical data matched with aerial imagery from Google Earth. During the field verification, the required number of points were revised, up to a minimum of 22 field positions to cover the site with a large enough buffer to trigger shutdown in time.

Figure 1 below shows the defined areas covered by each proposed shutdown vantage point. Vantage points would cover between 1 and 7 turbine locations with viewsheds of up to 2km used across the whole site.

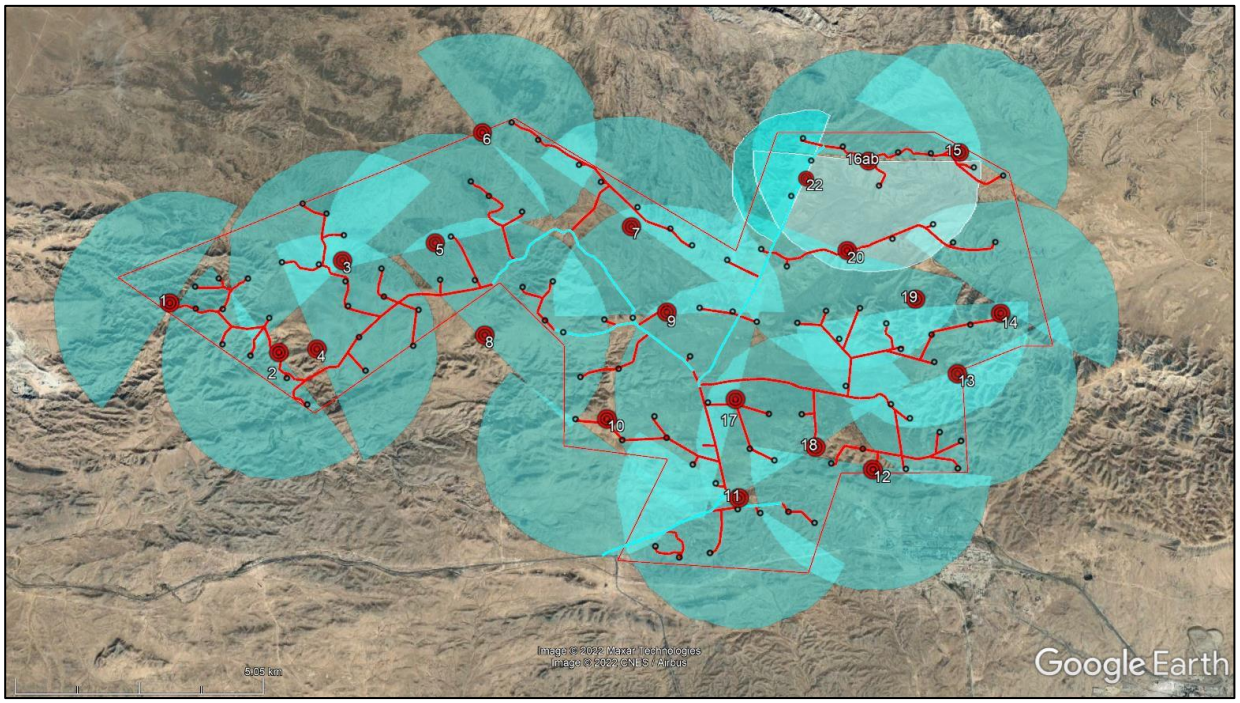


Figure 1 – Shutdown on Demand Vantage Points

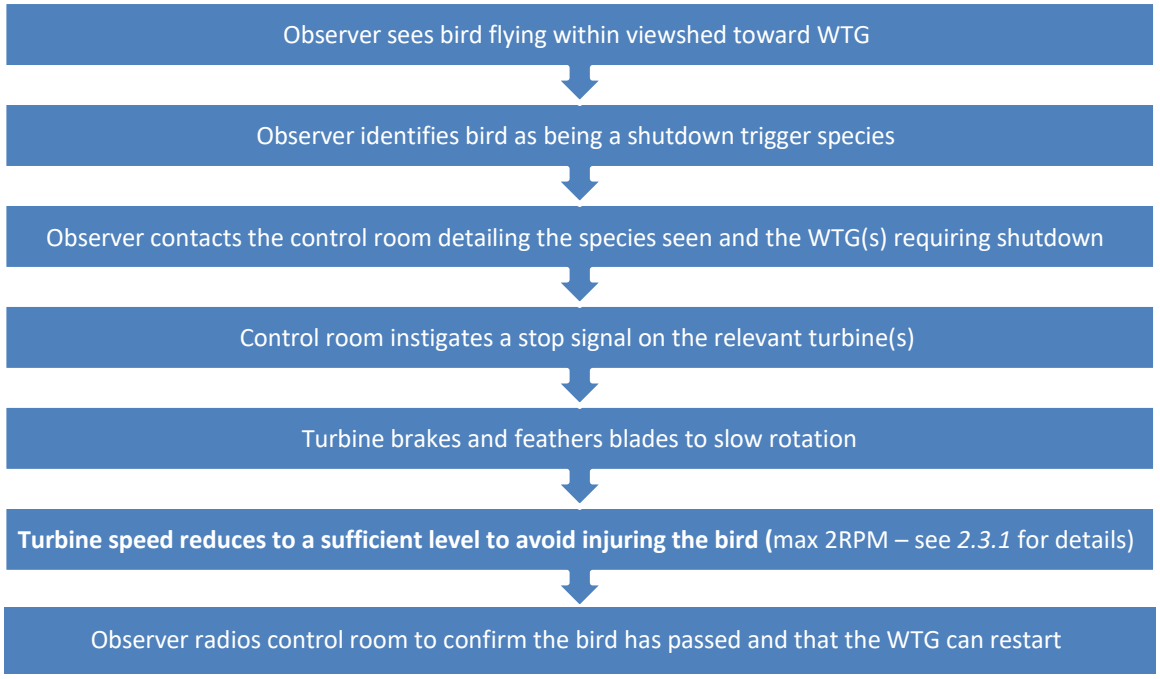
In addition to ground truthing, the survey points also recorded information on the accessibility of each point, noted any obstacles to the viewsheds which may restrict views, estimated the percentage of viewshed visible and also what contact options would be most appropriate from each location (*e.g.* mobile phone, long-range radio, satellite phone).

During the site visit, it was noted that the vast majority of proposed survey points were relatively easily accessible. A small number were more than a short (15 min) walk from the nearest existing or proposed road however the accessibility would be improved in most cases following work on site to allow road access to all turbines.

Mobile phone coverage is unfortunately possible in less than half the vantage points meaning dedicated long range radios would be required for observers to call for shutdown. Given under half the proposed position have reliable cell phone service which would mean high range radios would need to be used by the surveyors to communicate between their positions and the control room.

The majority of VPs are suitable for use with a clear viewshed covering the appropriate distance for shutdown. Three have views of less than the required distance meaning sufficient time for detection, identification and shutdown procedure would be difficult.

Even with appropriate VPs, the process for calling for turbines to be shutdown has a multitude of links in the process which must each fully align for shutdown to be achieved. The overall process is limited by technology and human efficiency and has the potential to break down for example if more than one surveyor needs to communicate a shutdown request at any one time, or if more than one bird is present within a viewshed at any one time. The below process outlines each step and the responsible roles.



2.2.2. Logistical Feasibility

In order to cover the 22 required vantage points with sufficient personnel we calculated that upwards of 60 survey staff would be needed to be employed by the Project. This number of personnel would ensure the shift length was not so long that observers lose concentration or be exposed to adverse weather conditions for long periods of time (max of 6hrs) and also to give an appropriate spread of coverage over times such as holidays, weekends and sickness. Management of this high number of surveyors and a detailed programme of training would also require a team of experienced human resources experts and ecologists.

The number of professional ornithologists with the appropriate existing skillset and knowledge currently working within Uzbekistan was estimated at approximately 20 individuals. This would make it essential from the outset to bring in experienced observers from overseas, with a view to engaging with the universities within Uzbekistan who currently offer degrees in natural sciences so that students may be recruited each year and so reduce the burden of overseas recruitment. It was estimated that roughly 50 students graduate each year with a degree in an applicable subject. If half of these graduates could be recruited each year and there was no turnover from new recruits it would still take at least three years to acquire enough staff members to fill all the required roles.

It is acknowledged that field observers do not require educational qualifications in order to be excellent field staff which could increase the pool of potential observers. However during discussions with local ornithologists, it was considered that within Uzbekistan recreational ornithology is at such a low level that it was reasonable to assume that those with an interest in ornithology were likely to follow in to academic programs. This has possibly led to a possible underestimate in the potential to recruit observers however it is believed from experience of in country ornithologists that this error would be so minor as not to impact the assessment of feasibility.

The costs associated with running the above based on supplementing the in-country experience with observers from the international market are likely to be extremely expensive. It has been estimated that the costs for recruiting staff, training them on the correct survey methodologies, employing international ornithologists in the initial stages, data management and supervision would cost somewhere in the region of 1,100,000 USD per year for at least the first 3 years, with the potential that with more input from universities this would then reduce to 750,000 USD per year in subsequent years. Overall personnel costs have been estimated at over 18 million USD for the 25-year lifespan of the Project. The projected costs are based on the fees of national observers in line with the salary of biology teachers which is considered a comparative career choice for those leaving biological related degree programs. The costs are not exhaustive and do not fully detail costs for items such as accommodation, equipment fit for task, vehicles and transportation, inflation, higher than expected staff turnover or need for additional survey points meaning the actual cost could be higher. They do however provide a rough idea of costs given the information available at this point.

2.3. Technology led shutdown

The second approach which has been considered is the use of technology to automatically trigger turbine shutdown when a species of high conservation status or high risk is approaching the turbine. For this, several technologies, including the radar-based systems Robin Radar and DTBird, and the camera-based system, IdentiFlight were considered. At a very early stage of consideration, the radar-based approach was not found to be feasible in terms of success of operation when compared to either the observer led shutdown or the Identiflight approach as detailed below. Whilst Radar based technology was removed, in part due to the challenging terrain with steep valleys, the Identiflight option has proven effectiveness at coping with similar terrain at Cattle Hill (where steeper terrain is in fact present). DTBird has evidence of recording between 76% and 96% of flights[1] meaning up to 24% of flights would not enact a deterrent. This level of risk is too great even before the efficacy of the deterrent and risks of habituation are brought in to play and accordingly (along with expert opinion from the Lenders ornithologist on the site visit) this was rejected.

1

Roel May, Øyvind Hamre, Roald Vang, Torgeir Nygård. 2012. Evaluation of the DTBird video-system at the Smøla wind-power plant. Detection capabilities for capturing near-turbine avian behaviour. NINA Report 910. Affiliation: Norwegian Institute for Nature Research

2.3.1. Technical Feasibility

The Project has investigated at length the feasibility of the installation of the Identiflight camera-based system which has a strong and growing evidence base for its efficacy. An example of this is from trials at an operational site in the USA where the system was shown to reduce fatalities over 80% when compared with a control site[2]. For context if similar results are achieved at the Zarafshan site this could theoretically reduce predicted annual collisions of Egyptian Vulture (in absence of the other mitigation we are proposing) from between approximately 5.8 and 2.5 to between 1 and 0.46 birds per year. As discussed within the ESIA the results at Cattle Hill (a site of similar topography) show that the shutdown is effective in avoiding collisions for around 99.91% flight and accordingly this reduces the annual collisions to between 0.0023 and 0.0053 birds per year.

The Identiflight system has been developed by Boulder Imaging Inc. and, using camera modules, it works from dawn to dusk to detect birds flying within turbine buffer zones of 1.2km. Images of any bird flying within the buffer are taken and processed using artificial intelligence to compare the image parameters to those held on the database and determine species (if the species is one held in the database). If the species is one which would require shutdown a trigger is automatically sent to the relevant turbine to brake and slow the blades. Turbines will be feathered to ensure a rotation of a maximum of 2RPM. Whilst the threshold for this activity is the US is considered to be 2.5 RPM the use of 2RPM is chosen based on data from the Cattle Hill project where this is the rotation maximum used during shut-down events. This speed has proven effective in avoidance of collision and impact at a site with similar topographic features and it is considered this is a suitable benchmark with which to work. On projects using the same Goldwind turbine type as that proposed for this Project, the time between a bird being detected and the turbines reaching shutdown speed has typically been under 60 seconds, with the fastest time being around 30 seconds. The system can function within relatively undulating terrain, with the cameras capable of "seeing" up to approximately 18° below horizontal.

The Identiflight system relies on a database of images of each species requiring shutdown, many of the species found at Zarafshan are already on this database however some "training" will be required to ensure all species of concern are covered. Even assuming that all species require further images the Project operators have arranged for a mobile Identiflight unit to be installed in the field and, connected to a generator unit for power this will be able to begin data collection within a relatively short time frame. This unit will primarily be used for the collection of images of Bearded Vulture and Saker Falcon and allow the existing databases of Cinereous Vulture, Egyptian Vulture, Bearded Vulture, Steppe Eagle, Imperial Eagle and Booted Eagle to be added to.

The unit will be in place around Q1 2023 and will be moved around the site and within the local area (outside the site) based on targeting locations with increased likelihood of interacting with the required species. This method will reduce the time required to capture the right number of images and ensure enough images are captured. Images will be checked by Identiflight in house ornithologists, but a representative number of images will also be verified by an international ornithologist.

[2] McClure CJW, Rolek BW, Dunn L, McCabe JD, Martinson L, Katzner T. Eagle fatalities are reduced by automated curtailment of wind turbines. *J Appl Ecol*. 2021;00:1–7

Given the status of the bird species present on site shut down on demand protocols would be required for the entirety of the operational period of the Project unless data to suggest the contrary is collected and further agreement is reached.

Whilst the technical feasibility appears suitable, from the outset of the Project, the technology led protocols will be subject to field verification conducted by experienced ornithologists to ensure the systems are detecting birds efficiently and shutting down effectively (simulated shutdowns will be instigated during the first phases of installation prior to WTGs becoming operational). It is likely that teams of between 2-4 ornithologists would be required to fulfil this task and where possible at least some of the personnel will be surveyors with previous experience in the Project area. It is likely that the team would be on site for one month of each season over the first three years of the project unless it is considered by the lenders that verification is proven prior to this period.

Turbines will be installed onsite in phases, with approximately 6-8 turbines being erected per month for the initial phases of construction. At the same time, permanent Identiflight cameras will be installed and tested. Construction work will begin in the far western side of the site as this is the furthest point from the more sensitive parts of the site. The Identiflight project support staff have studied the site layout and terrain and proposed that 74 Identiflight units will be required to cover the 111 WTGs of the Project, a map showing these is shown in Figure 2. These locations give a higher coverage to those parts of the site where terrain or landscape limits the available viewshed and help to fill in any gaps in coverage caused by this.

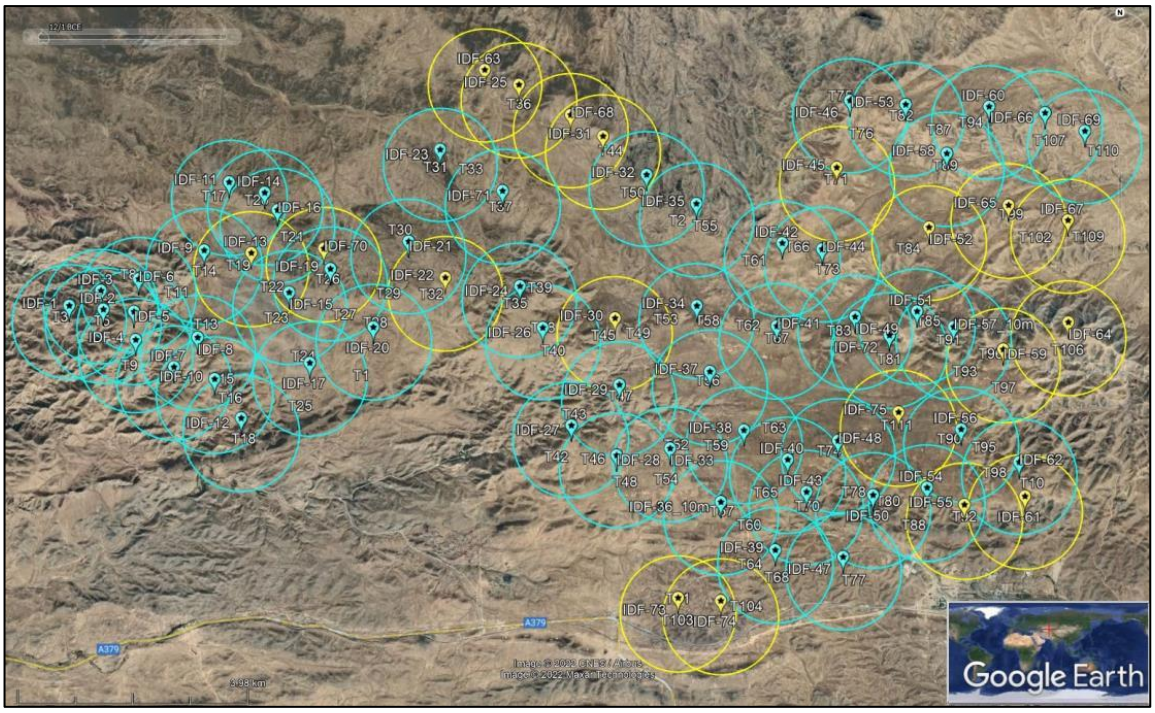


Figure 2 – Location of Identiflight Units on Site

The onsite Identiflight verification process will be performed by the Shutdown on Demand Monitoring Team (the Team). The Team will be led by an independent, external expert who possesses the necessary experience and qualifications for performing the role successfully.

Under management of the external expert, the Team would require around 3 suitably trained and experienced surveyors to be present daily covering a number of VPs to view the area containing the phase of WTG being constructed at that time (likely to be 1-2 VPs) along with a buffer comparable to that of the Identiflight unit (estimated to be approximately 1,000 – 1,200 m). The surveyors are likely to include members of the survey teams who completed surveys in 2020-21 so will be familiar with the site and surrounds.

The exact methods for verification will be detailed within the relevant onsite protocol documents and will include, but not be limited, to recording:

- observations of bird flight activity on standard survey form and maps to be compared daily to the flight times and tracks of the Identiflight system;
- Whilst instructions to shutdown will not come from observers they will record details of flights where an observer considers that if observer led shutdown had been in place then a shutdown would be initiated and the final outcome of the at- risk flight including;
    - was Identiflight triggered in order to avoid a collision?
    - would human shutdown have acted any differently (quicker/slower) and what the impact of this would have been in terms of near misses or unnecessary shutdowns?

If at any point in the three years monitoring observers are spotting more bird activity or birds of different species the number or locations of Identiflight units may be increased to cover any gaps, or adjustments may be made to the angle of the unit. Additional monitoring time may be required in this instance, but this will be agreed at the time with the lenders. Testing of the Identiflight system in other parts of the world has been shown to be multiple times more effective that human observers, with up to 96% of birds detected by the cameras[3]. A Good International Industry Practice program of Post Construction Fatality Monitoring will be implemented in order to monitor the effectiveness of the Identiflight program.

2.3.2. Logistical Feasibility

Day to day management of the Identiflight system and image verification of any unknown species or anomalies will be performed by an employed Project team leader. The role of the Team Leader will be to manage this system (although image verification will be sent out to a suitably experienced international ornithologist) as well as be responsible for managing the post construction fatality monitoring teams. It is a requirement that the Project engages at least one experienced ornithologist over the life of operation so that unknown images can be identified and if needed the shutdown protocols updated. The Identiflight modules are built to record at a temperature appropriate for the conditions within the site. There are no known risks to getting Identiflight units into Uzbekistan and Identiflight have confirmed their ability to produce the required amount of units, this is also helped by the phased construction. The project is supported by the Government mean the risk to delay receiving units in the country is reduced.

The costs associated with the installation and operation of the Identiflight system are higher than those anticipated with purely observer led shutdown, however the practicalities of operation of the Identiflight system provide considerable benefits and are likely to give a higher level of protection for bird species on site. Cost estimates for the installation of the Identiflight systems as well as the observer team conducting field verification surveys for three years have been calculated as approximately $9.5 million USD, in addition a monthly service and maintenance charge of $359 USD per Identiflight camera unit is charged which equates to approximately $7.5 million USD over the duration of the project.

[3] C.J.W. McClure, L. Martinson, T.D. Allison Automated monitoring for birds in flight: proof of concept with eagles at a wind power facility Biol. Conserv., 224 (2018), pp. 26-33, 10.1016/j.biocon.2018.04.041

3. CONCLUSIONS

In conclusion, it is considered that, whilst both observer led shutdown and Identiflight led shutdown have their own constraints, both are technically feasible. Observer led shutdown on demand has greater technical constraints to feasibility given the scale of the exercise (number of observers and potential for breakdown of shutdown system) and overall detection rates. In terms of resources, it is far **less** feasible to implement the observer led approach than the technology led approach of Identiflight. This is based on the number of observers required year-round and the ability to source them and adequately cover the associated logistics. Identiflight requires far lower day-to-day resources, with the majority of system management and monitoring achievable, once up and running and tested, by a single member of staff. The level of detection is also likely to be higher than that achieved by human observers as per McClure *et al* 2018. Accordingly, it is considered that use of Identiflight is the most appropriate way of managing collision risk at this site and, given the resources available by the developer, the scope of the project and the upfront testing of the system by observers it is considered feasible to use effectively.

4. APPENDIX 1 – SSOD VP CRITERIA

- Proposed SSOD VP number;
- Coordinates;
- Viewing direction;
- Turbines covered;
- Pictures (N/S/E/W);
- Date assessed;
- Weather/visibility;
- Distance visible;
- Obstacles to viewshed;
- Percentage of viewshed visible;
- Current access proximity;
- Planned new access road proximity;
- Contact feasibility (mobile phone coverage, long range radio, sat phone etc).

5. APPENDIX 2 – SITE PHOTOGRAPHS

A selection of representative photographs showing views from proposed Shutdown on Demand Vantage Points

VP2

SSOD VP 2 Views North and East

SSOD VP 2 Views South and West

VP 4

SSOD VP 4 Views North and East

SSOD VP 4 Views South and West

VP 7

SSOD VP 7 Views North and East

SSOD VP 7 Views South and West

VP15

SSOD VP 15 Views North and East

SSOD VP 15 Views South and West

VP20

SSOD VP 20 Views North and East

SSOD VP 20 Views South and West